[002] This application is a national stage completion of PCT/EP2003/009073 filed August 16, 2003 which claims priority from German Application Serial No. 102 38 128.3 filed August 21, 2002.

[003] FIELD OF THE INVENTION

[004] The invention concerns a method for the control of a drive train of a vehicle~~, in accord with the principal concept of the accompanying claim 1, wherein the said method is more closely defined.~~

[005] BACKGROUND OF THE INVENTION

[015] ~~In accord with the invention, this purpose is achieved by the features of the attached claim 1.~~

[016] SUMMARY OF THE INVENTION

[024] BRIEF DESCRIPTION OF THE DRAWINGS

[025] ~~Further advantages and developments of the invention are made evident in the claims and can be inferred from the following with the aid of the drawing of principal embodiments. The drawings show~~ The invention will now be described, by way of example, with reference to the accompanying drawings in which:

[037] DETAILED DESCRIPTION OF THE INVENTION

[046] The common internal gear 17 of the second planetary gear set 14 is bound to a sun gear 21 of the range group 9, whereby, between the sun gear 21 and an internal gear 22 of the range group 9, a plurality of planetary gears roll, which have been rotationally secured upon a planetary gear carrier 23 of the range group 9, which is connected to the output drive.

[050] An intershift between the individual gear stages "III-H", "IV", "V", "VI", "VII" and "VIII" of the multi-group transmission 4 is carried out by a change of the ratio of the automatic transmission 8 which, advantageously, is in accord with a preselected or with a specified shifting program which, for example, has been input into the control apparatus of the multi-group [[24]] transmission 4 or the control of the automatic transmission 8.

[066] With this information, it becomes clear that in connection with the presentation in Fig. 3, that the change of the ratio stage in the range group from "low" to "high" or from "high" to "low" is particularly of advantage, if in the automatic transmission the ratio of "A3" is shifted into the ratio "A1" (or vice versa) simultaneously. The ratio of the multi-group transmission 4 remains, in such a case, essentially the same, on which account a combining speed of rotation of the motor 2 compared to the desired speed of rotation of the multi-group transmission 4, with which the range group 9 is synchronized, essentially, is the same as the speed of rotation of the motor 2 compared to the ratio which is actuated in the multi-group transmission 4.

[079] This means that the internal gear [[23]] 22 of the range group 9 is released from its fixation on the transmission housing 20A of the range group 9 and now becomes capable of rotation. From this point of time, the rotational speed n_{22} of the internal gear 22 of the range group 9 increases gradually in the direction of the rotational speed n_{23} of the planetary carrier 23 of the range group 9.

[080] From a point in time T_3, transfer capabilities for closing or opening, which belong to the automatic transmission 8, are so established that reductions were made in the speed of rotation n_{16} of the second sun gear 16 of the second planetary gear set 14; the speed of rotation n_{17} of the common internal gear 17 of the second planetary gear set 14; the speed of rotation n_{18} of the first planetary carrier 18 of the second planetary gear set 14, and the speed of rotation n_{19} of the second planetary carrier 19 of the second planetary gear set 14. The speed of rotation n_{13} of the planetary carrier 13 of the first planetary gear set 10; the speed of rotation n_{15} of the first sun gear 15 of the second

planetary gear set 14, and the driving speed of rotation n_{mot} of the motor 2 remain essentially practically unchanged.

[081] The establishment of the capability of transfer of the shifting elements of the automatic transmission 8 allows, a matching of the speed of rotation n_{22} of the internal gear 22 of the range group 9 to the speed of rotation n_{23} in combination with the signaling of the e-gas-moment m_{mot-e}, until the speeds of rotation n_{22} and n_{23} are identical. At this moment, the second shifting element 25 of the range group 9 is synchronized and can be released or closed. This instant of time is more exactly characterized in Fig. 6 by the term T_2.

[085] Dependent upon the respective ratio established in the range group 9, the individual gear stages "I", "II", "III", "IV", "V" and "VI" of the multi-group transmission 4 possess those ratios which are set forth in a bar diagram in Fig. 8. The total height of one bar represents respectively a ratio of the individual gear stages "I", "II", "III", "IV", "V" and "VI" of the multi-group transmission 4, if the selection "low" has been activated for the range group 9. The individual gear stages "I", "II", "III", "IV", "V" and "VI" of the multi-group transmission 4 are respectively actuated by a corresponding change of the ratios of the automatic transmission, whereby the respective ratio of the gear stages "I", "II", "III", "IV", "V" and "VI" of the multi-group transmission 4 depends upon the ratio actuated in the range group 9.

[086] In the range group 9, if the ratio stage "low" is in use, then those ratios are made available for the individual gear stage "I", "II", "III", "IV", "V" and "VI" of the multi-group transmission 4 which are indicated by the cross hatched bars of Fig. 8. This means that the multi-group transmission 4 in the ratio stage "low" of the range group 9 possesses six gears; the ratio values of which run between, for example, 11.3 and 1.87. In the range group 9, if the ratio "high" has been selected, then the multi-group transmission 4, likewise, exhibits six gears; the ratio values of which lie between 4.17 and 0.69, for example.

[092] The advantages of the method whereby, with a change of the ratio of the range group 9, a corresponding counter shifting takes place in the automatic transmission 8 and does this without a change in the velocity v_{fzg} of the vehicle, are clarified in Fig. 8 by arrows 28, 29. At a change of the ratio of the range group 9 from "low" to "high", if when the automatic transmission 8 is in the shifting mode "A6", a counter shift in the automatic transmission 8 into the ratio "A3" occurs then a merging speed of rotation of the motor 2 of the new gear of the multi-group transmission 4 deviates considerably less from the speed of rotation n_{mot} of the motor 2 at the ratio "A6L" of the multi-group transmission 4, than would be the case if this were done without counter shifting in the automatic transmission 8.

[093] The merging speed of rotation n_{mot} of the motor 2, which would be shifted into without a corresponding counter shift in the automatic transmission 8, is indicated by the additional arrow 29 in Fig. 8. This large cross-over of speed of rotation is disadvantageous for the comfort of driving, since a compensating time, while the speed of rotation of the motor 2 to the new speed, that is to say, a connecting speed of rotation is achieved, is much longer than is the case with lesser speed of rotation differences. The disadvantage arises from the fact, that the drive train, during the compensation time, is relieved of duty and the shifting causes a break in the delivery of tractive force, which, under certain circumstances causes a continuation of existing travel upward on a steep incline to be impossible.

[094] After the removal of load from the drive train 1 and correspondingly, also from the first shifting element 24 of the range group 9, the torque of the motor 2, i.e., e-gas-moment m_{mot-e}, is held constant and in a subsequent control phase, is adjusted in such a manner as shown in Fig. 10 that, in accord with the torque m_{mot} of the motor 2 as well as with the speed of rotation of the same, namely n_{mot}, a synchronization is made of the second shifting element 25 of the range group 9. This allows a new ratio to be set in the closable shifting element of the automatic transmission 8.

[095] Torque curves (vs time) are shown in Fig. 10, corresponding to the speed of rotation curves (vs time) for the individual components of the drive train 1 are

shown in Fig. 11. At a point of time T_0, at which a driver's demand for a change in a ratio in the range group 9 is made, namely a change from the ratio "low" to the ratio "high", which the driver actuates by the shift-selector 27, in accord with the said demand, the shifting begins in the multi-group transmission 4, which calls for a change of the speed of rotation, i.e., a change of the curves of the individual speeds of rotation of those elements which are to co-act in the shifting of the drive train 1.

[098] The motor 2 speed of rotation n_{mot} can be brought essentially more quickly to the connection rotational speed n_{mot-a} with the preselected procedure than this can be accomplished with a sole adjustment of the e-gas-moment. In this way in the present case, the motor 2 is advantageously braked by an increase of the transfer capability of the closable shifting elements of the automatic transmission [[9]] 8. The closable shifting elements of the automatic transmission 8 are operating in a so-called "slip-phase" and brake the motor 2 at the corresponding connection speed of rotation of the motor 2 in the shortest possible time. The control of the shifting elements of the automatic transmission, which are to be shifted, is carried out in such a manner that by a controlled mutual frictional contacting of the shifting elements, a transfer capability of the required value is made available.

[101] The above described synchronization of the shifting elements of the automatic transmission 8 and the range group 9, which take part in the shifting of the multi-group transmission 4, form the basis of the speed of rotation curves shown in Fig. 11, namely n_{13}, n_{15}, n_{16}, n_{17}, n_{18}, n_{19}, n_{22}, and n_{23}. The point of time T_0 marks the beginning of the shifting phase in the multi-group transmission 4. In this application, contrary to the description accompanying Fig. 6, the shifting is not an automated shifting, but is executed in accord with a demand at the driver's option. With the generation of the driver's optional demand for the shifting into the ratio "low" in the range group 9, a capability of transfer of the shifting element of the automatic transmission 8 is so adjusted that the speeds of rotation n_{13}, n_{15}, n_{18}, n_{19}, and the motor speed of rotation n_{mot}

are all reduced. The speed of rotation n_{23} of the planetary gear carrier 23 of the range group 9 remains essentially unchanged in this operation.

[105] The two above described embodiment examples indicate the advantageous situation that mechanical synchronization in the range group 9 can be eliminated, whereby a reduction of traction-moment and an accompanying reduction of fuel consumption would take place. Additionally, a result of the no longer necessary mechanical synchronization, savings in weight, engine space, and cost advantages become available with the invented dog-clutch equipped range group.

[106] Moreover, with the invented method, considerable shortening of the elapsed time of interruptions in traction can be gained during the changes of the ratios in the range group 9 as compared to such time-saving with conventional methods. In the embodiment example as shown in the Figs. 2 to 5, the change of the ratio in the range group is automatic and the driver is thus relieved of this duty.